

Polarization Issues in Run8

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Polarization and beam intensity

RHIC emittance and beam intensity

Emittance in AGS and BtA

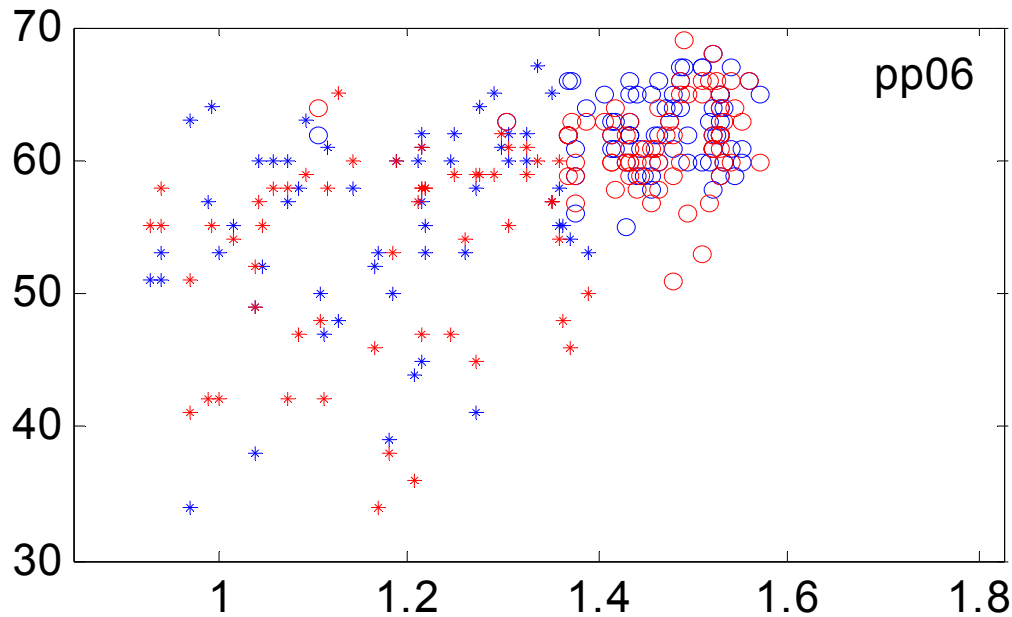
Booster settings in pp06 and pp08

Effect of the Booster vertical scraping

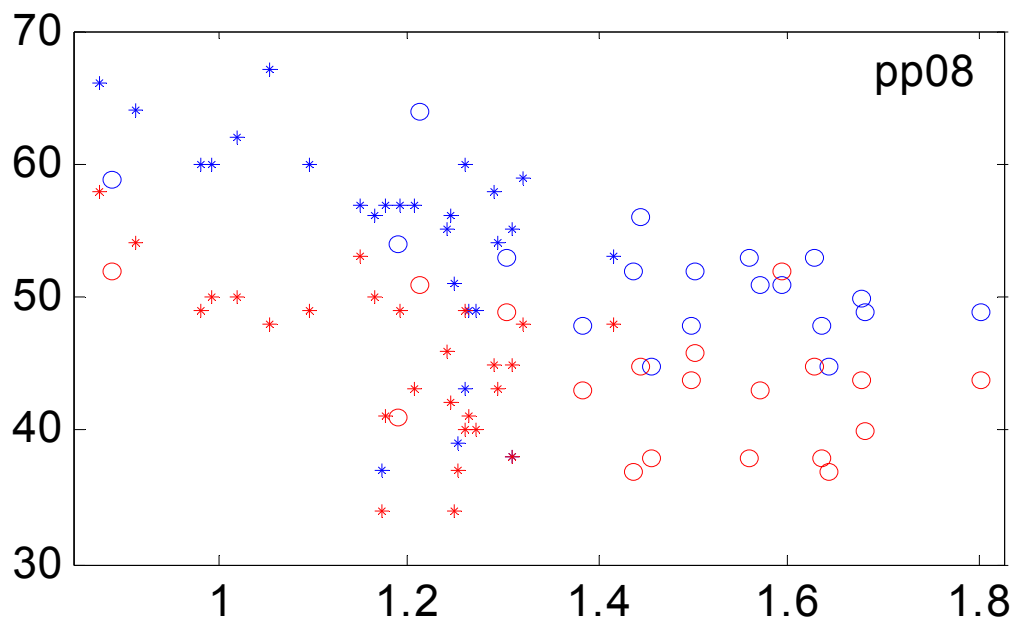
Summary and questions

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Polarization at RHIC early store



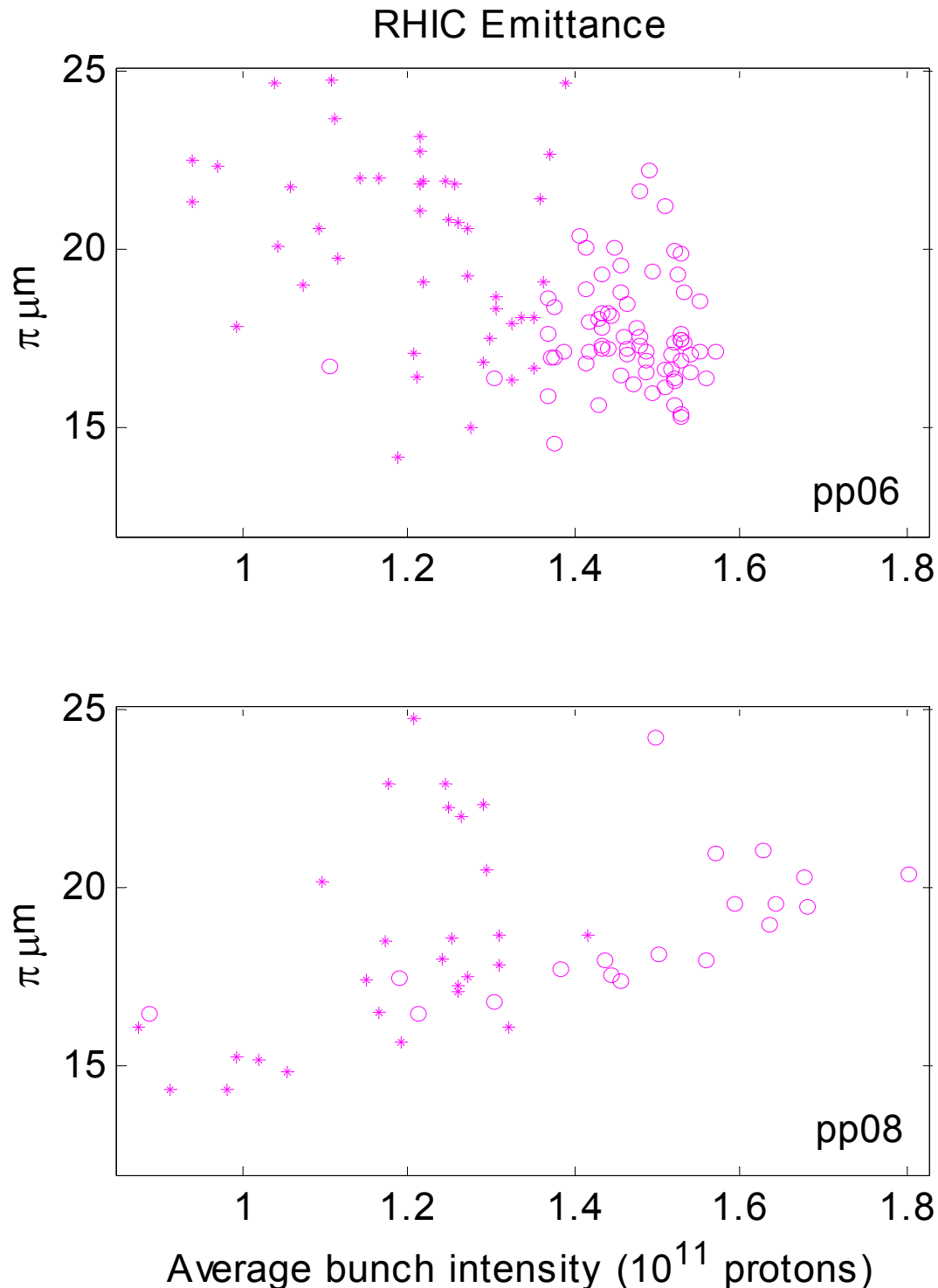
Blue: Blue ring, Red: Yellow ring



Average bunch intensity (10^{11} protons)

Polarization vs. intensity

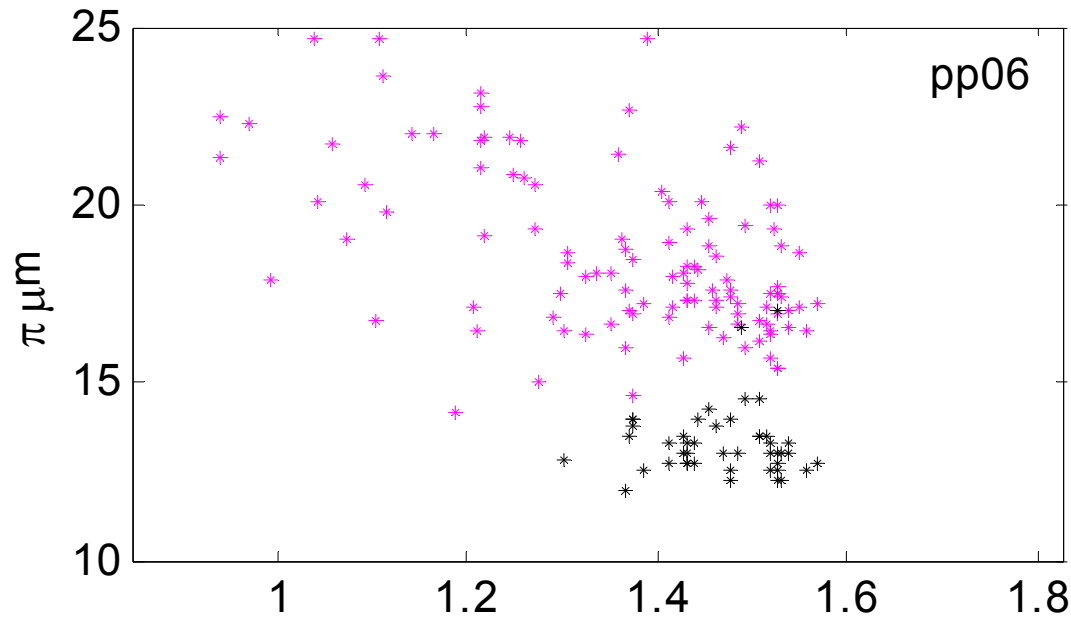
- Bunch intensity is taken at the RHIC injection, $\sim 95\%$ of the AGS extraction.
- Polarization is taken at the early store. Yellow problem in pp08 is not discussed.
- Circles in pp06: after the one-week shutdown. Circles in pp08: with the AGS injection on front porch (User 2).
- Polarization in pp06 has no dependence on intensity, up to $\sim 1.6e11$ protons.
- In pp08, polarization has a clear dependence on the intensity: from $1e11$ to $1.8e11$, polarization in RHIC is reduced from $\sim 65\%$ to 50% .



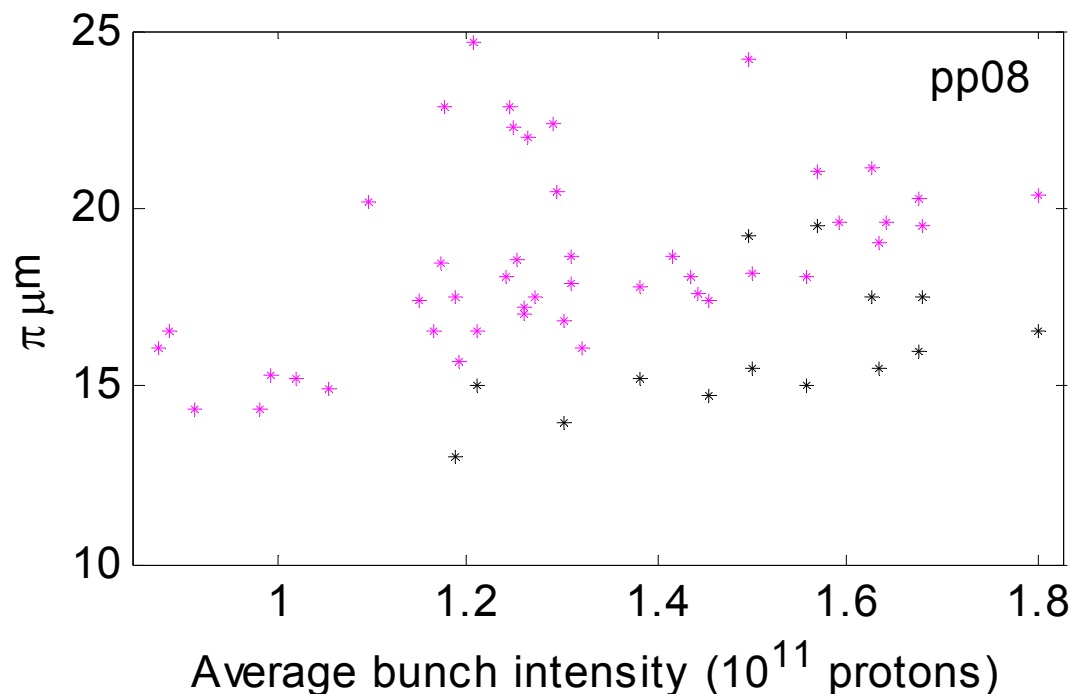
RHIC emittance vs. intensity

- The emittance in pp06 is evaluated using the ZDC coincident rate at 1.5 hours after the accramp event.
- For pp08, it is evaluated
 - using the PHENIX ZDC rate at the beginning of the collision.
 - ZDC cross section is (tentatively) set to 10% smaller than in pp06.
- The RHIC beam emittance dependence on AGS intensity is to watch.
- The dependence is almost absent in pp06, but it is strong in pp08: $\sim 40\%$ increase from the bunch intensity of $1e11$ to $1.8e11$ protons.

Emittance, RHIC and AGS



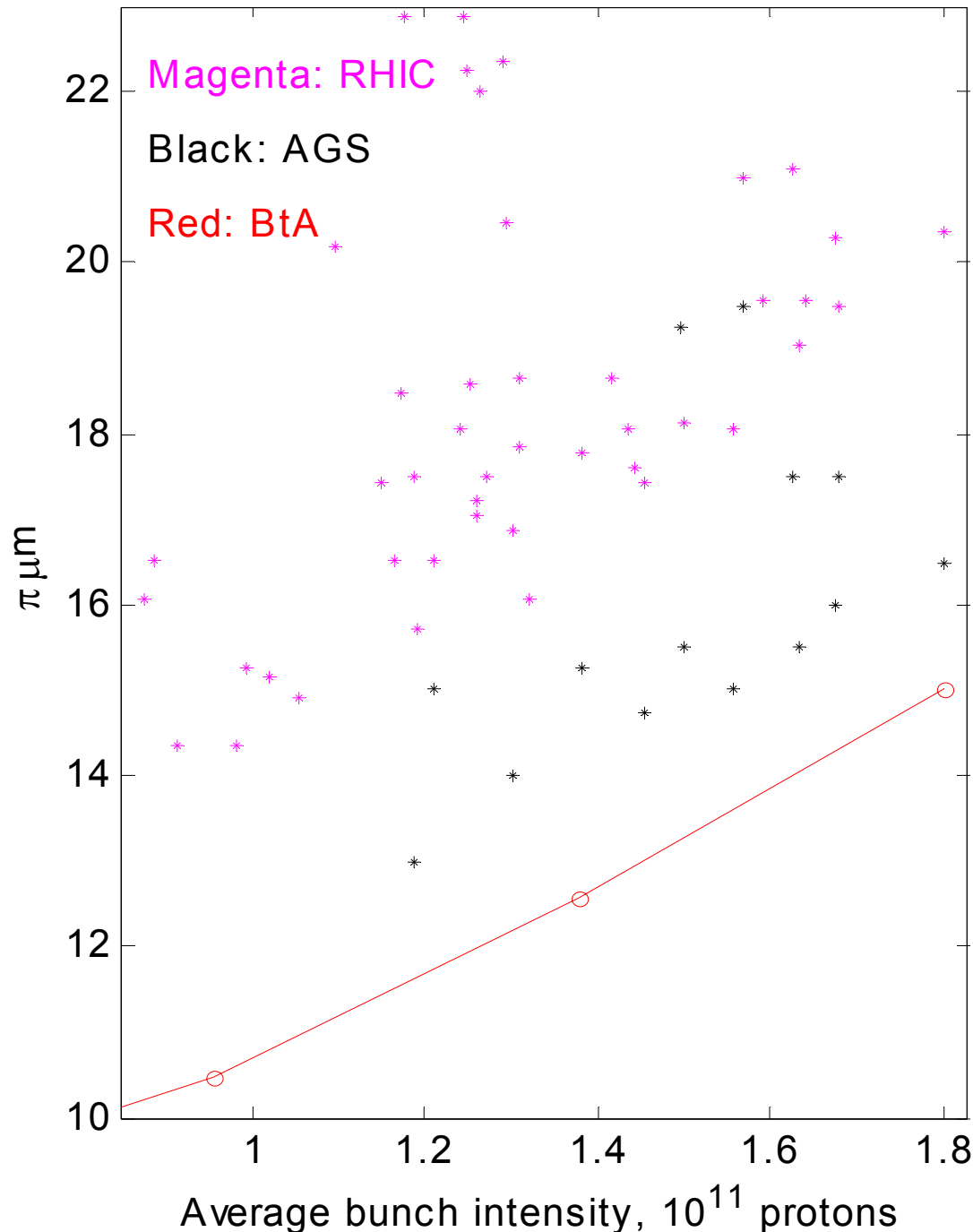
Magenta: RHIC, Black: AGS



Emittance in AGS

- Emittance in AGS is measured by the IPM at 810 ms with RF off.
- After one-week shutdown in pp06, the H/V emittance in AGS changed from typically 13/12 to 11/15 $\pi \mu\text{m}$. The latter did not change with the intensity from 1.3×10^{11} to $\sim 1.6 \times 10^{11}$ protons.
- In pp08, with the AGS User 2, the AGS IPM pattern looks similar to later pp06.
- The average (H/V) AGS emittance is compared with the RHIC emittance. The dependence of AGS emittance on intensity is absent in pp06, but it is strong in pp08.

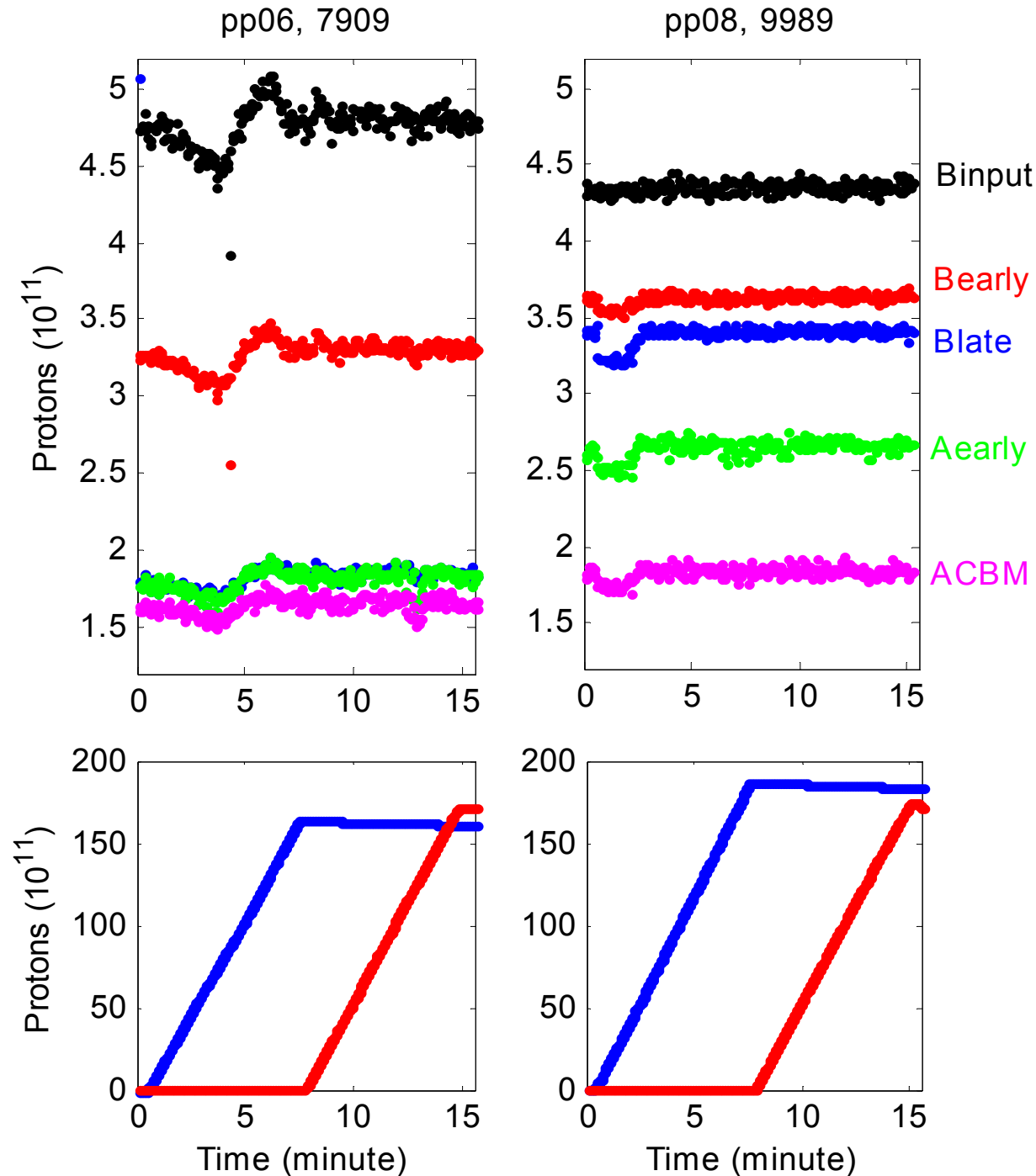
RHIC, AGS and BtA Emittance



Emittance in BtA

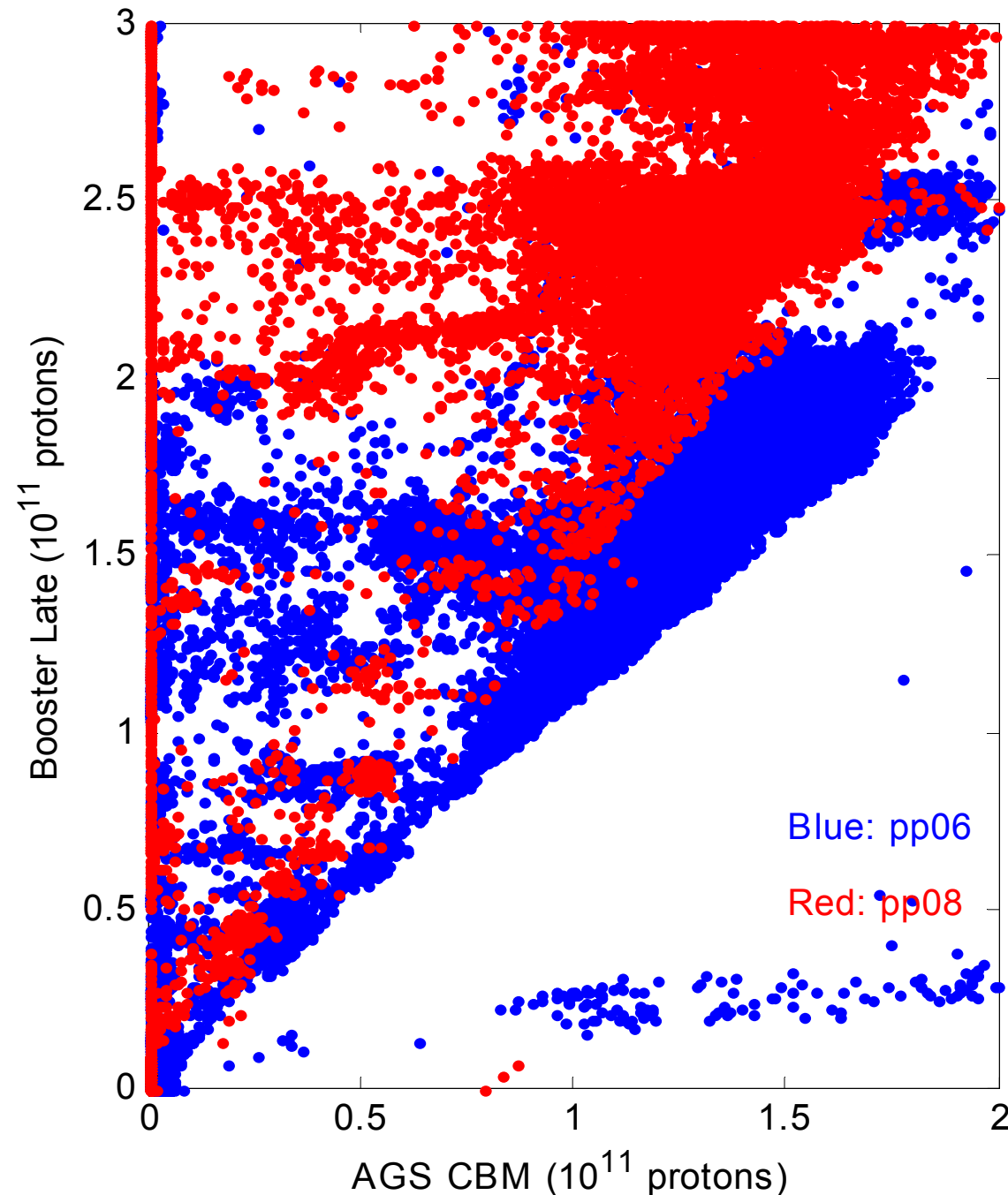
- Add Leif's BtA beam size measurement in pp08. For Booster late intensity of 0.95, 1.8, 2.6 and 3.4e11, the vertical beam sizes are 0.73, 0.80, 0.90, 1.0, and horizontal is 0.82, 0.87, 0.93, 1.0. Takes the H/V average.
- Assuming 3.4e11 at Booster late yields 1.8e11 in RHIC with the emittance of 15 $\pi \mu\text{m}$, the BtA emittance shows similar dependence on intensity as RHIC and AGS.
- If true, then the source of the emittance dependence on intensity in pp08 is traced to the Booster.

Booster settings, I



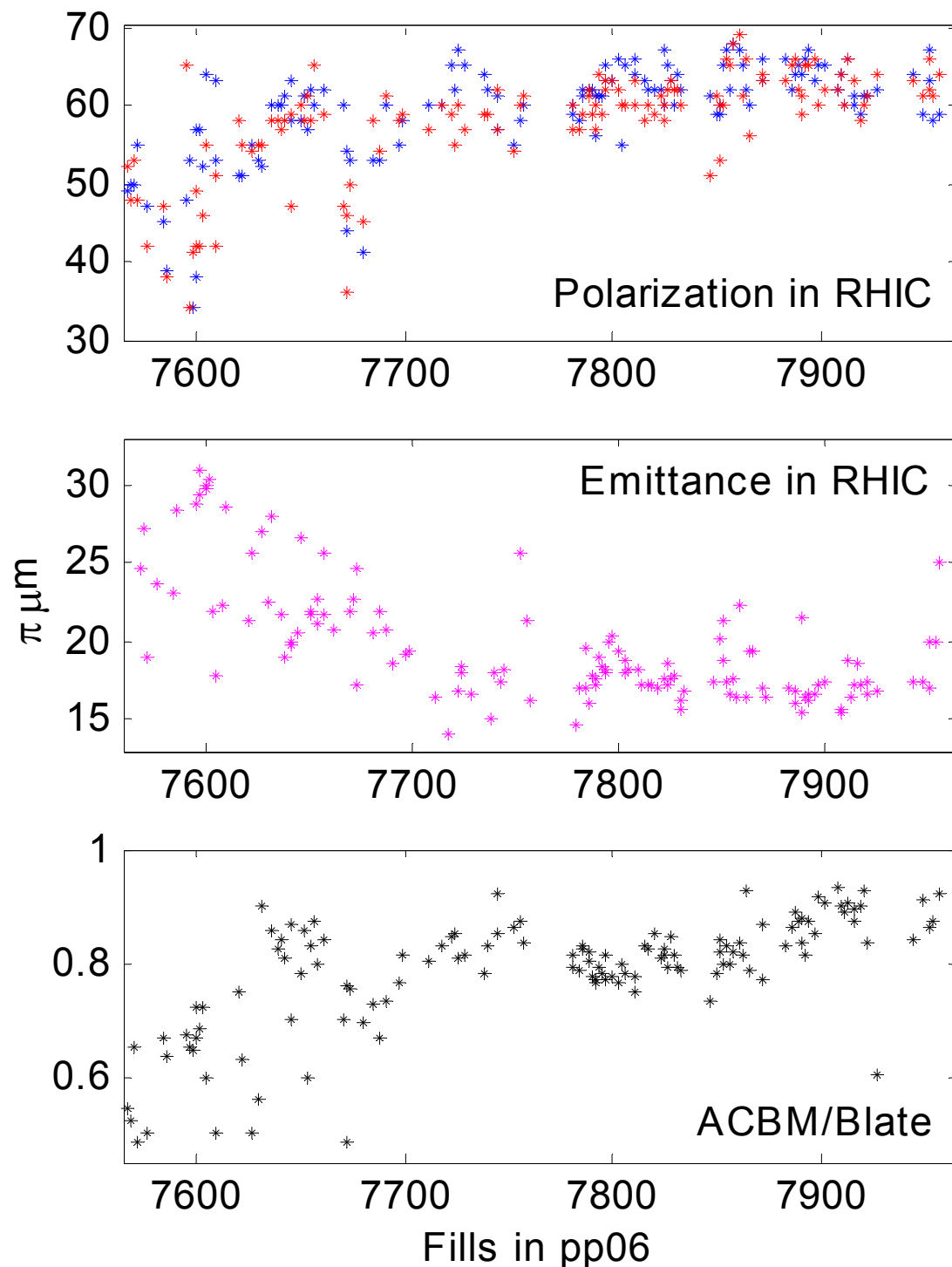
- Compare Booster settings for the golden fills 7909 in pp06, and 9989 in pp08.
- The degree of the Booster vertical scraping can be estimated from the ratio of Booster late / Booster input. This ratio is < 0.4 for 7909 in pp06, and it is ~ 0.8 for 9989 in pp08.
- The transmission of AGS CBM / Booster late, including the Booster extraction, BtA transfer, AGS injection, and AGS acceleration, is affected by the Booster vertical scraping. For 7909 it is $\sim 90\%$, and for 9989 $\sim 50\%$.

Booster Late vs. AGS CBM



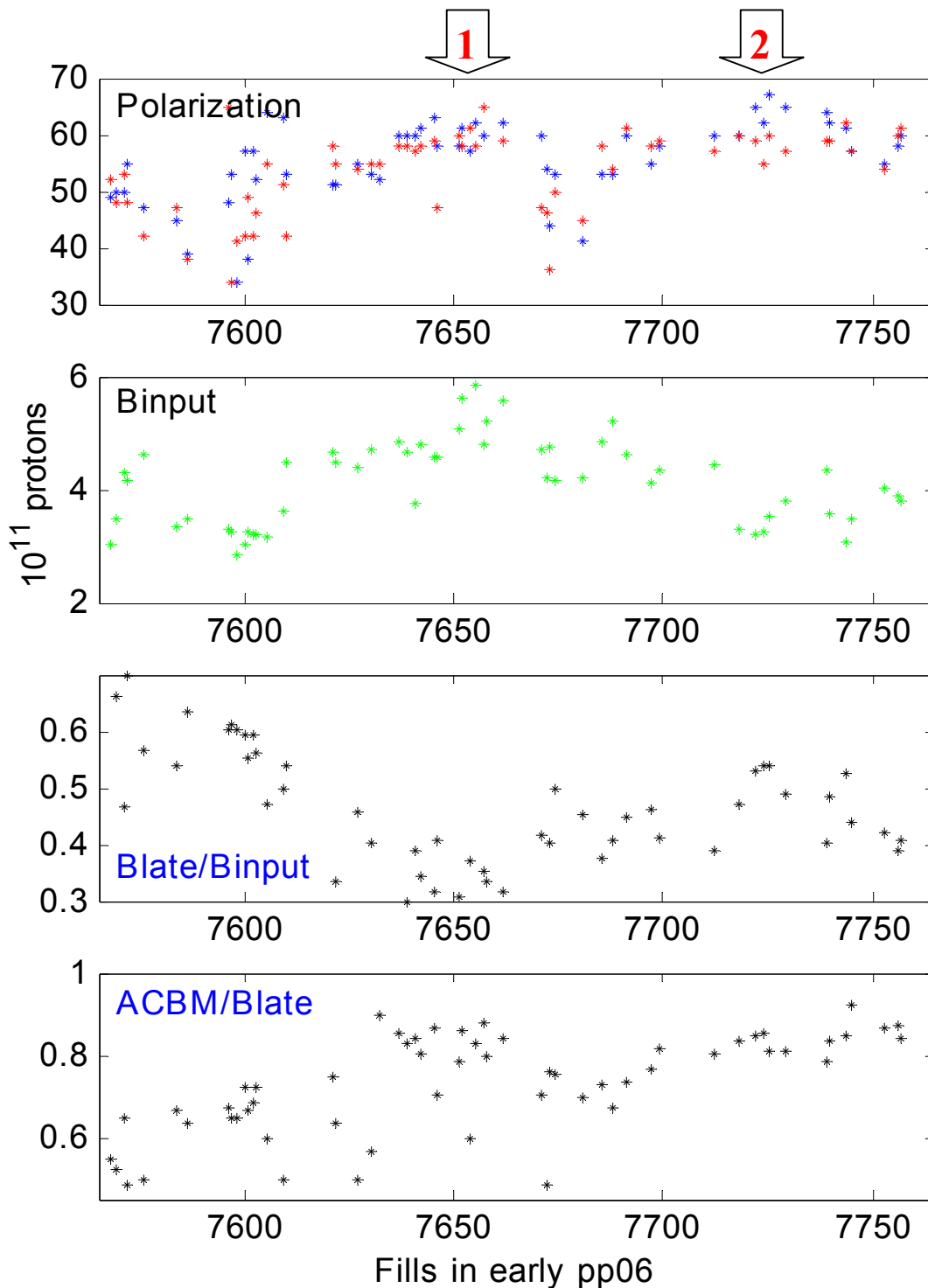
Booster settings, II

- The Booster settings of 7909 and 9989 are in general representative for later pp06 and pp08, respectively.
- AGS CBM is compared with the Booster late. Blue is for fills 7847 to 7912, 2 weeks in later pp06. Red is for fills 9954 to 10002, 2 weeks in later pp08.
- The ratio of AGS CBM / Booster late is typically 0.9 for later pp06, and 0.6 for later pp08.
- The typical Blate/Binput in pp06 is 0.35. It is 0.6 in pp08, indicating lighter/no vertical scraping.



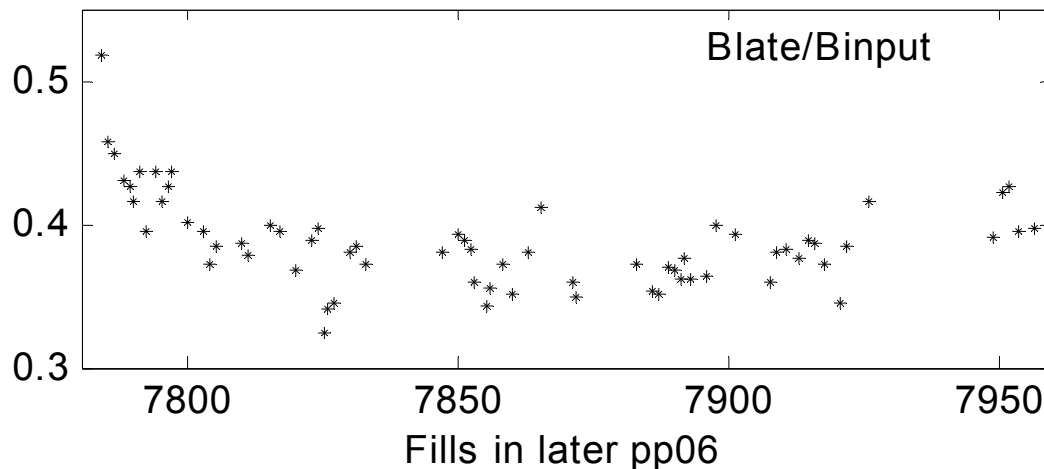
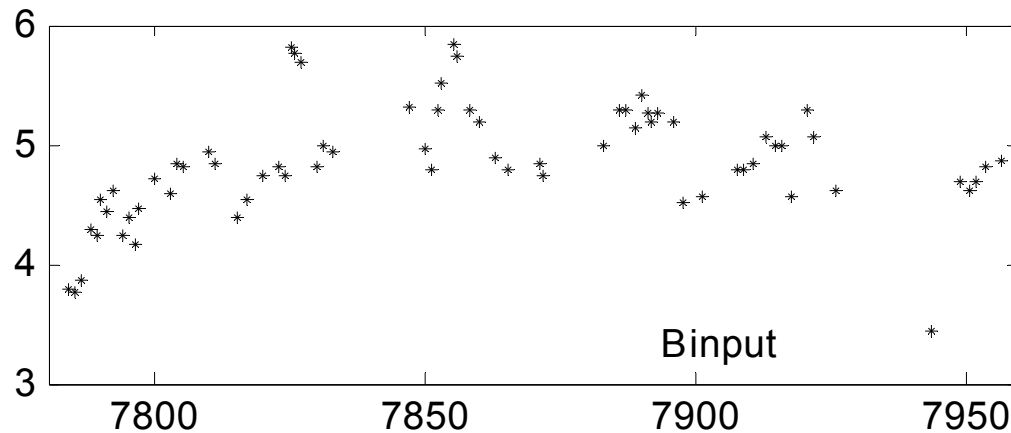
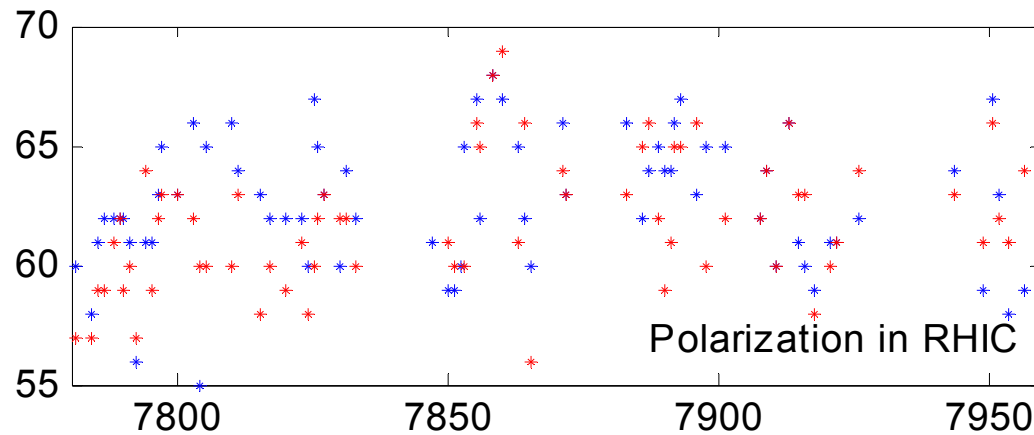
Effect of the Booster scraping in pp06

- In general, more Booster vertical scraping leads to better transmission from Booster late to AGS CBM, i.e., the larger the ACBM/Blate, the more the Booster vertical scraping.
- For the early pp06, from fills 7568 to ~ 7720, the ratio of ACBM/Blate was increased from < 0.6 to > 0.8 , i.e., the vertical scraping increased.
- At the same period of time, the polarization in RHIC was improved, and the beam emittance in RHIC was reduced.



Closer look at early pp06

- For ~ 10 fills centered at 7650, marked by **1**, the Booster vertical scraping is heavy ($B_{late}/B_{input} \leq 0.4$), the transmission from Booster late to AGS CBM is improved ($ACBM/B_{late} \geq 0.8$). The polarization in RHIC is peaked at around 60%.
- For 5 fills centered at 7722, marked by **2**, the Booster vertical scraping is light ($B_{late}/B_{input} \approx 0.55$), but the polarization is high. The reason might be the low Booster input intensity, $\sim 3.5 \times 10^{11}$ protons.



Closer look at later pp06

- The Booster vertical scraping was gradually increased from fill 7760 to 7850 (Blate/Binput is reduced from ~ 0.5 to < 0.4). At the same time, the RHIC polarization is improved.
- During this period of time, the Booster input intensity was increased from $4e11$ to $\sim 5.5e11$ protons, mainly by setting larger chopper width.
- The effect of the Booster vertical scraping overrides the increased Booster input intensity on polarization.

Summary and Questions

1. Polarization in pp06 has no dependence on AGS intensity. In pp08, there is a clear dependence for $> 1e11$ protons.
2. Dependence of the RHIC emittance on AGS intensity is absent in pp06, but it is strong in pp08. The AGS emittance measured by IPM is in agreement with this conclusion.
3. The beam size measured in BtA shows that the source of the emittance dependence on intensity might be in the Booster.
4. The Booster vertical scraping helped improvement of both polarization and emittance in pp06. In pp08, the Booster vertical scraping is never fully applied, possible reasons:
 - Once switched to AGS User 2, only 11 days left to the end of run.
 - The first half of this period of time is devoted to intensity push.
5. The most important question is: Could we get 65% polarization in pp08 if the Booster scraping was fully applied?
6. Other questions include:
 - The limit of the Booster vertical scraping in terms of intensity, effect.
 - How much the polarization reduction is due to the emittance growth?
 - The role played by the LINAC beam.